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Design and feasibility of a novel sprinkler control algorithm for swine heat stress alleviation

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Design and feasibility of a novel sprinkler control algorithm for swine heat stress alleviation

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010 Effects of increasing space allowance by removing a pig or gate adjustment on finishing pig growth performance. C. B. Carpenter*, C. J. Holder, M. D. Tokach, J. M. DeRouchey, J. C. Woodworth, R. D. Goodband, and S. S. Dritz, *Kansas State University, Manhattan*

A total of 256 pigs (PIC 327 × 1050; initially 55.9 kg) were used in a 71-d study to determine the effects of space allowance and pig removal on finishing pig performance. The 4 treatments included: 0.91m^2/pig or 0.63m^2/pig for the entire study and initially 0.63m^2/pig with a gate adjusted or the heaviest pig removed to keep pigs above their predicted minimum space requirement (m^2 = 0.0336*BW$^{0.66}$). Initially, there were 8 pigs/pen and 8 pens/treatment. From d 0 to 28, prior to any space adjustments, ADG was marginally greater (P = 0.076) for pigs provided 0.91m^2 compared with those provided 0.63m^2. From d 28 to 71, ADG and ADFI decreased (P = 0.001) when pigs were provided 0.63m^2 compared with pigs provided 0.91m^2. Pigs provided increased space by removing pigs had similar performance to those where gates were adjusted; however, pig removal resulted in lower ADFI than pigs allowed 0.91m^2 throughout the experiment. Overall, pigs allowed 0.91m^2 had increased (P = 0.001) ADG compared with pigs allowed 0.63m^2 or either adjusted space treatment. Removing pigs or adjusting gating increased (P = 0.001) ADG compared to those kept at 0.63m^2; however, neither treatment had ADG similar to pigs allowed 0.91m^2. Pigs allowed 0.91m^2 had greater (P = 0.001) ADFI compared with pigs allowed 0.63m^2 with adjusted space allowance pigs being intermediate. Feed efficiency was not affected in the cumulative growth periods. In summary, either removing a pig or adjusting the gating as pigs reached the critical *k*-value influenced growth similarly. Results indicate the performance benefit from removing the heaviest pigs from the pen is primarily from increased space allowance. Pigs provided more space as they reached the space requirement had lower growth than unrestricted pigs indicating the minimum space prediction equation (m^2 = *0.0336*BW$^{0.66}$) doesn't fully explain pen space effects on pig performance.

Key Words: finishing pig, growth, space
doi:10.2527/asasmw.2017.010

011 Withdrawn

012 Design and feasibility of a novel sprinkler control algorithm for swine heat stress alleviation. B. C. Ramirez*, S. J. Hoff, J. D. Harmon, *Agricultural and Biosystems Engineering, Iowa State University, Ames.*

Pigs have a relatively low capacity to dissipate excess body heat and depend more on reducing metabolic heat production through a reduction in voluntary feed intake in hot conditions, resulting in a growth performance decrease. Effectiveness of current cooling devices (e.g., evaporative coolers or sprinklers) in facilities is governed by the Water Vapor Pressure (WVP) concentration gradient between the air (a function of dry-bulb temperature, t_{db}; relative humidity, RH; and atmospheric pressure) and saturated WVP at a wet surface. Traditional sprinkler control systems (TSCS) often operate solely on t_{db} feedback and at fixed "off" intervals to allow dispersed water to evaporate. This control strategy does not account for the WVP concentration gradient; hence, water is wasted and only a limited amount of latent heat can be removed from the animal. Therefore, the objectives were to develop and simulate a novel variable interval sprinkler control system (VISCoS) that dynamically changes the "off" interval based on t_{db}, RH, and airspeed feedback. A theoretical convective mass transfer model (i.e., evaporation) was developed to estimate water evaporation rate as a function of the thermal environment, surface area, skin temperature, and volume of water applied. A pig's geometry was assumed a cylinder approximately 30% wet with a 1-mm film of water. The feasibility of implementing VISCoS was evaluated at six locations (AZ, IA, MN, MO, IN, and NC) by simulating water usage for a 1000 hd, mechanically ventilated,

Table 010.

Item[1]	0.91m^2	0.63m^2	Gate adjustment	Pig removal	SEM	Probability, P <
BW, kg						
d 0	55.9	56.0	55.9	55.6	0.15	0.361
d 28	84.0^{x}	82.3^{y}	82.6^{y}	82.8^{y}	0.47	0.081
d 71	127.3^{a}	121.7^{c}	124.9^{b}	122.5^{c}	0.73	0.001
d 0 to 28						
ADG, kg	1.00^{x}	0.94^{y}	0.95^{y}	0.97^{xy}	0.015	0.076
ADFI, kg	2.39	2.28	2.35	2.37	0.036	0.200
d 28 to 71						
ADG, kg	1.01^{a}	0.92^{b}	0.98^{a}	0.98^{a}	0.013	0.001
ADFI, kg	3.01^{a}	2.77^{c}	2.97^{ab}	2.89^{b}	0.035	0.001
d 0 to 71						
ADG, kg	1.00^{a}	0.93^{c}	0.97^{b}	0.98^{b}	0.009	0.001
ADFI, kg	2.76^{a}	2.58^{c}	2.73^{ab}	2.66^{b}	0.029	0.001

[1]Means within a row differ: $^{abc}P < 0.05$, $^{xyz}P < 0.10$.

grow-finish building with an assumed water delivery (75.71 L/min), sprinkler "on" time (30 s), and constant BW (100 kg). Typical meteorological year 3 weather data (365 d) was used to determine outdoor t_{db} and RH at each location, where indoor t_{db} was assumed 2°C greater than outdoor t_{db} with a 2 m/s air velocity across the animal's back. The VISCoS performance was compared with two TSCSs with fixed "off" intervals (15 and 30 min; "on" $t_{db} \geq 29.44$°C). Simulation results for each region showed water usage for 15 min (154, 72, 60, 50, 80, 164 m^3) and 30 min (79, 37, 31, 26, 41, 83 m^3) "off" interval TSCS to be greater than VISCoS (49, 15, 8, 10, 17, 44 m^3). Duration (±SD) for complete water evaporation estimated by VISCoS (19.6 ± 1.4, 28.0 ± 3.6, 27.8 ± 2.5, 31.8 ± 6.5, 32.2 ± 3.3, 26.9 ± 3.3 min) varied by region and provides insight on incorporating more thermal environment measurements to reduce water usage in swine facilities.

Key Words: housing, humidity, temperature
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013 Evaluating the health and productivity of weaned piglets after simulated transport and heat stress when antibiotics are eliminated from the diet.

J. S. Johnson*, D. C. Lay Jr., *USDA-ARS Livestock Behavior Research Unit, West Lafayette, IN.*

The study objective was to evaluate the effects of post-weaning transport during heat stress (HS) on post-transport piglet health and productivity when dietary antibiotics were removed or replaced with a nutraceutical. Sixty mixed sex piglets from 10 sows (n = 6 piglets/sow) were weaned (18.8 ± 0.8 d of age) and then herded up ramps into one of two simulated transport trailers in thermoneutral (TN; 28.8 ± 0.2°C; n = 30 piglets) or HS (cyclical 32 to 37°C; n = 30 piglets) conditions for 12 h. This procedure is referred to as simulated transport, as in piglets are weaned from the sow, herded down an alley and up a ramp into a trailer, fans simulated air movement, and feed and water were withheld; however, trailer movement was not simulated, only the regrouping, isolation, and duration component. Following the 12-h simulated transport, piglets were unloaded from the trailer, weighed, and then housed individually in TN conditions (28.5 ± 0.1°C; 29.1 ± 0.1% RH) and assigned to one of three dietary treatments balanced by weaning weight, sex, sow, and transport environment. Treatments were dietary antibiotics [A; n = 20 piglets; 5.5 ± 0.2 kg BW; chlortetracycline (400 g/ton) + tiamulin (35 g/ton)], no dietary antibiotics (NA; n = 20 piglets; 5.6 ± 0.2 kg BW), or 0.20% L-glutamine (GLU; n = 20 piglets; 5.6 ± 0.2 kg BW) fed for 14 d. Feed intake (FI), BW, and behaviors were monitored daily. On d 15, all piglets were euthanized and intestinal samples were collected for histology. Data were analyzed using PROC MIXED in SAS 9.4 and pig was the experimental unit. Throughout the 14-d dietary treatment phase, FI was greater overall (P < 0.01; 60.3%) in GLU compared to A and NA pigs and tended to be greater (P = 0.08; 37.7%) in A compared to NA pigs. BW was greater overall (P < 0.01; 8.7%) in GLU and A compared to NA pigs, but no differences were detected between A and GLU pigs. Lying behavior was greater (P = 0.05; 11.7%) in NA compared to A and GLU piglets in the first 2 d following simulated transport, indicating greater illness behavior in NA pigs. The villus height to crypt depth ratio was greater (P < 0.05) in the duodenum (12.1%) and jejunum (12.8%) for A and GLU compared to NA pigs and greater in the ileum (15.6%) for GLU compared to A and NA pigs. No temperature by diet treatment differences were observed with any comparison. In summary, withholding dietary antibiotics after weaning and transport can increase illness behaviors, reduce productivity, and negatively alter intestinal morphology compared to dietary antibiotic or L-glutamine provision.

Key Words: antibiotics, heat stress, transport
doi: 10.2527/asasmw.2017.013

014 Dynamic space requirements of lame and non-lame sows determined by the lying-standing sequence.

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Increasing consumer awareness of animal production systems has influenced housing specifications through legislation in several countries. Understanding how sows utilize their dynamic space could assist in gestation housing design specifications. The aim of this study was to calculate the dynamic space requirements for lame and non-lame sows during a lying-standing postural sequence. A total of 85 multiparous sows (parity range 0 to 4) were used in this study. Lameness was evaluated when each sow was moved from its gestation stall to a pen using a 3-point scale while walking (1 = normal to 3 = severely lame). Individual sows were moved to a pen on gestation Days 30, 60, and 90, and a ceiling camera above the pen recorded one lying down-standing up event. Observations ceased when the sow laid-down and stood-up or if 2.5 h elapsed from recording commencement. Two space measurement methods were conducted after still frames of lying-down and standing-up sequences were combined into a single image and measured in Adobe Photoshop Elements by (1) counting the number of pixels by contouring the sows' body or (2) overlaying a grid on the sow image. Lameness was reclassified as non-lame (score 1) and lame (scores ≥ 2), and parity was reclassified as 1, 2, and 3+. Data were analyzed using mixed model equations methods. Models included lameness status,